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Derivation and Application of a Food Utility Index (FUI) for European Wild Boar (*Sus scrofa* L.)

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Abstract

A Food Utility Index (FUI) is presented for European wild boar (*Sus scrofa* L.), derived from the experimental butchery of two individuals of differing ages. The results differ from FUIs produced for other species because of the different conformation of the species. Application of the FUI to the wild boar assemblage from the Mesolithic site of Ringkloster (Denmark) allows increased understanding of field butchery, transport and processing of the animals.

Keywords: Food Utility Index, Fui, Boar, Skeletal Element Frequency, Butchery, Ringkloster

Introduction

Binford's (1978) ground-breaking work on the economic anatomy of caribou and sheep revolutionised zooarchaeological studies of animal bone representation. It allows an understanding of how hunters select high-utility joints for transport and consumption elsewhere, leaving lower-utility parts at the kill-site. This in turn provides a heuristic tool for exploring the articulation of hunter-gatherer societies on a regional scale (e.g. Legge and Rowley-Conwy 1988; Rowley-Conwy 1993). The logic of economic anatomy similarly underpins analyses of bone representation in domestic animals. For example, zooarchaeological studies of urban sites can distinguish between 'domestic' and 'specialised' butchery, and, in the latter case, between various stages in carcass processing (e.g. Maltby 1989; O'Connor 1993; Dobney *et al.* 1996; Gidney 2000; Stokes 2000). Such studies may also provide evidence to support a distinction between domestic animals, slaughtered at the point of consumption and represented by all body parts, and wild animals butchered where killed, and so represented only by transported bones (e.g. Legge 2000; Halstead 1987).

It is however dangerous to apply a model of economic anatomy based on caribou and sheep to species of very different anatomical conformation. Indices have therefore been developed for various other taxa including both marine mammals (e.g. Savelle *et al.* 1996) and also other species of terrestrial mammal such as bison (Emerson, quoted in Lyman 1994, Table 7.4) and horse (Outram and Rowley-Conwy 1998). One of the species most commonly encountered on Eurasian archaeological sites representing both hunting and farming communities is the near-ubiquitous wild boar and its domestic counterpart the pig (*Sus scrofa* L.). The lack of an utility index for pig particularly needs to be addressed because of the distinctive bodily

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conformation of the species, which differs radically from all those taxa so far considered. This contribution redresses this lack.

Materials

Two farmed sows were selected for butchery. Both sows were of wild boar stock, reared outdoors under an extensive regime designed to yield lean 'gamey' meat for the gourmet restaurant trade. Farmed boar were selected for this study because they retain the rangey build and slow growth rate of wild boar and, presumably, of early domestic pigs. They should therefore be appropriate comparanda for both true wild boar and most premodern domestic pigs.

One carcass was from an ex-breeding sow 92 months old, with a dressed (eviscerated and bled) weight of 73 kg. The second carcass was from a young sow aged 14 months, with a dressed weight of 41 kg. The sample was limited to two animals for reasons of cost. The younger animal represents an age category commonly found in assemblages from both hunted and farmed populations; both breeders and butchers report that there is not much difference in weight and build between the sexes at this age. The older animal is less representative of an adult male, certainly in absolute weight and probably also in build. An adult *female* was selected on the grounds that this sex is likely to be better represented among adults in most archaeological assemblages, at least from agricultural settlements and probably many hunter-gatherer ones as well.

Methods

Both dressed carcasses were dismembered and filletted by an experienced professional butcher, Mr. Barry Robinson of Sheffield, England, using standard modern tools, in the presence of the authors. The carcasses were separated into the following sections: skull, mandible (both with and without tongue), atlas with axis, cervical vertebrae 3–7, thorax (including ribs, vertebrae and sternum), lumbar vertebrae, pelvis with sacrum, and (separately for left and right sides of the body) scapula, humerus, radius with ulna, carpals with metacarpals, anterior phalanges, femur, tibia with fibula and tarsals, metatarsals, and posterior phalanges (Fig. 1). These are the same anatomical sections as in previous studies by Binford (1978) and Metcalfe and Jones (1988), with the exception that the thorax is treated as a single unit and not separated into thoracic vertebrae, ribs and sternum (see Outram and Rowley-Conwy 1998, 840).

The attribution of muscle to these anatomical

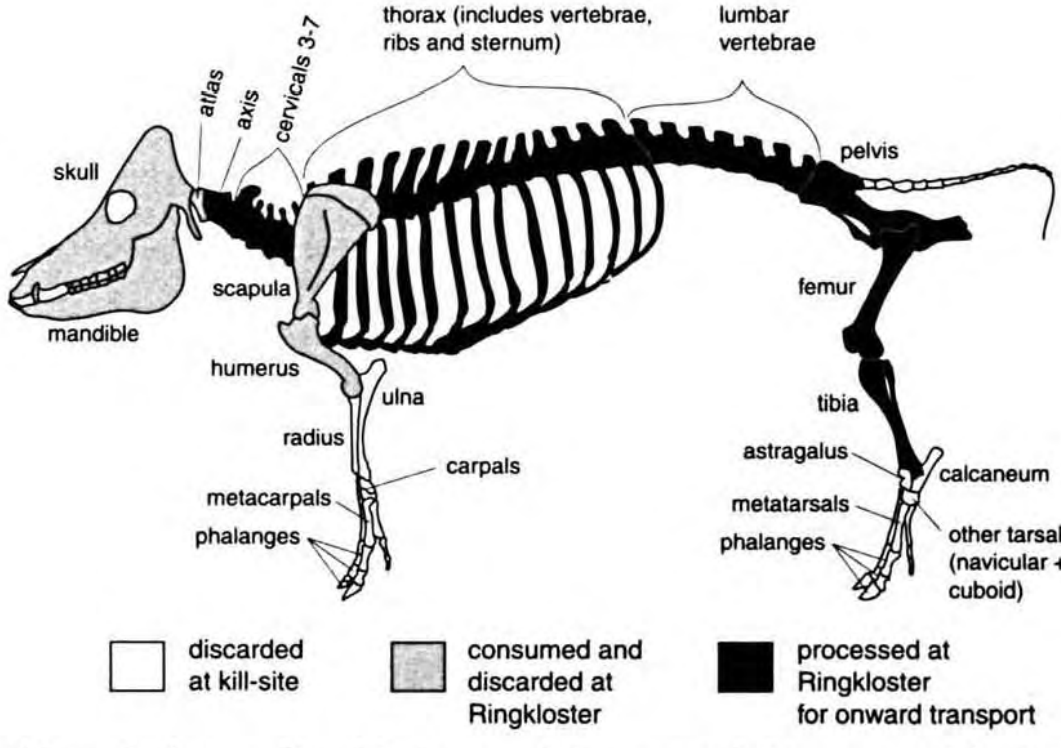

Figure 1. Skeleton of a boar, marking skeletal parts and the transport decisions suggested for the Ringkloster assemblage (see text).

sections was not always straightforward. Modern British butchers aim to remove individual muscle masses intact. Because these procedures are governed by custom as well as anatomical practicalities, it is somewhat arbitrary which muscle masses are removed with which skeletal part. This problem is particularly acute with regard to the shoulder (separation of scapula from proximal humerus) and ham (pelvis from proximal femur). In this study, the butcher was therefore asked to bisect muscle masses that might during normal butchery have remained attached in their entirety to one of two adjacent skeletal parts. Even so, variation in the angle of cutting through a muscle mass on occasion led to significant differences between left and right sides of the carcass. Such problems arise with all butchery experiments (e.g. Outram and Rowley-Conwy 1998, 840), but are arguably particularly acute in the case of pigs, the bones of which are relatively short and in some cases covered by very thick muscle masses.

The gross weight of each anatomical section was measured to the nearest 5 grams immediately after dismemberment and prior to boning out. Dry bone weights were measured (again to the nearest 5 grams) after burial for several months to remove within-bone nutrients. In the case of the appendicular skeleton, the values presented here are means for left and right carcass parts.

Binford (1978) presented separate utility indices for meat, marrow and bone grease; he then combined these into a General Utility Index (GUI). This was criticised as unnecessarily complex by Metcalfe and Jones (1988), who demonstrated that the Meat Utility Index (MUI) is virtually identical to the GUI and much easier to derive. The formula for the derivation of the MUI is: gross weight of part minus dry bone weight (Metcalfe and Jones 1988, 489 formula 3). The MUI thus comprises the combined weights of both meat and within-bone nutrients. This study follows Metcalfe and Jones in presenting a MUI, and deriving from it the standardised MUI (SMUI) in which the highest utility part is assigned a value of 100%, and the values of the other parts are scaled to this. This facilitates comparison between taxa.

Binford rightly observed that skeletal elements of low intrinsic utility might be selected for transport as 'riders' if they were anatomically adjacent to parts of higher utility. To allow for this, he proposed the Modified General Utility Index (MGUI). Metcalfe and Jones derived a similar index from their MUI, which they termed the Food Utility Index (FUI). Once again, for the purposes of comparison between taxa, a standardised FUI (SFUI) is derived. Following Metcalfe and Jones, we present here the FUI and SFUI for wild boar.

Results

The MUI are presented in Table 1, and the SMUI in Table 2. In each case separate indices are presented for the juvenile and adult sow, to explore age-related differences in build. For ease of zooarchaeological application, indices are also presented based on the mean of the values for the two animals.

As expected, high utility values in boar are concentrated in the axial skeleton and upper limbs. Thorax has the highest value, followed by the lumbar vertebrae, pelvis/sacrum and femur. Skull, mandible with tongue, atlas/axis, the other cervical vertebrae, and scapula have moderately high values. Humerus and tibia have lower values, and the more distal parts of the limbs have very low values.

The adult boar is altogether a more massive animal, and its MUI is greater than that of the juvenile throughout the skeleton (Fig. 2). The differences between the two are not however limited to absolute size: when their SMUI are compared, a number of relative differences are visible that reflect changes of conformation during growth (Table 2). In the adult, the atlas/axis, scapula and femur are relatively as well as absolutely heavier than in the juvenile, while cervical vertebrae 3–7, pelvis/sacrum and to a lesser extent humerus are *relatively* lighter in the adult.

Binford (1978) calculated MUI for two sheep, aged 6 months and 90 months, and these also show considerable age-related variation. Table 3 presents the MUI and SMUI for these animals, recalculated with the figures for thoracic vertebrae, ribs and sternum combined into a single thorax value to make them comparable to the wild boar discussed here. Fig. 3 plots the difference in SMUI between juvenile and adult for both sheep and wild boar. In some elements, the two species develop in parallel: the relative utility of lumbar vertebrae increases, while those of cervical vertebrae 3–7, pelvis/sacrum and humerus all decrease. In other elements, age-related changes are not consistent between the species: the relative utilities of skull and mandible increase markedly in sheep, but not in boar; that of atlas/axis increases in boar but not in sheep; and those of scapula and femur increase substantially in boar, but decrease in sheep. Of course, two individuals of each species are an inadequate sample for exploring the relationship between age and utility. Moreover, while the adults of the two species are of similar age, the younger individuals (the boar of 14 months and sheep of 6 months age) represent rather different stages of development. Nonetheless, it seems clear that both absolute and relative utility differ significantly

element	14 months			92 months			mean MUI
	total weight	dry bone weight	MUI	total weight	dry bone weight	MUI	
skull	2030	470	1560	3470	850	2620	2090
mandible w tongue	1665	290	1375	3075	515	2560	1970
w/o tongue	1455	290	1165	2540	515	2025	1595
atlas/axis	1455	45	1410	3360	50	3310	2360
cervicals 3-7	2015	75	1940	2645	130	2515	2230
thorax	11795	480	11315	20240	1030	19210	15260
lumbars	4205	140	4065	7710	245	7465	5765
scapula	925	55	870	3030	130	2900	1885
humerus	1175	110	1065	1325	215	1110	1090
radius/ulna	345	70	275	680	140	540	410
metacarpal/carpals	220	55	165	160	70	90	130
fore phalanges	105	40	65	80	35	45	55
pelvis/sacrum	4255	180	4075	5200	305	4895	4485
femur	2950	120	2830	6975	235	6740	4785
tibia/tarsals	680	165	515	1270	230	1040	780
metatarsal	210	45	165	145	45	100	135
hind phalanges	105	30	75	75	40	35	55
TOTAL	40850			73180			

Table 1. Derivation of Meat Utility Index (MUI) for wild boar. The mean MUI is the mean of the MUIs for the 14- and 92-month boars. The MUI for each animal is obtained by subtracting the dry bone weight from the total weight of each anatomical unit. Note that the values for all appendicular parts other than pelvis are the means for the left and right sides of the body. The total weights quoted are for the dressed carcasses and include both left- and right-sided appendicular parts. All weights in grams to the nearest 5 gr.

element	14 months	92 months	mean
skull	14	14	14
mandible w tongue	12	13	13
w/o tongue	10	11	10
atlas/axis	12	17	15
cervicals 3-7	17	13	15
thorax	100	100	100
lumbars	36	39	38
scapula	8	15	12
humerus	9	6	7
radius/ulna	2	3	3
metacarpal/carpals	1	0.6	1
fore phalanges	0.6	0.2	0.4
pelvis/sacrum	36	25	29
femur	25	35	31
tibia/tarsals	5	5	5
metatarsal	2	0.5	1
hind phalanges	0.7	0.2	0.4

Table 2. Standardised Meat Utility Index (SMUI) for wild boar. The mean SMUI in the right hand column is calculated from the mean MUI presented in Table 1. Note that the values for all appendicular parts other than pelvis are the means for the left and right sides of the body.

between age groups and that the nature of these age-related changes differs between species. Utility indices should therefore be applied with caution, taking due account not only of the species represented, but also of the demographic profile of each species (cf. Speth 1983, 113–7).

A comparison with both sheep and caribou serves further to highlight the distinctive features of boar MUI. Fig. 4 presents the SMUI for the three species, using the mean values for the juvenile and adult boar and for the juvenile and adult sheep. This comparison highlights two principal differences. Firstly, the atlas/axis and lumbar vertebrae are of much higher relative utility in boar than in caribou or sheep. The former, in particular, was immediately apparent during butchery of the boar, as the atlas and axis vertebrae were deeply embedded in a substantial 'collar' of meat and fat (Fig. 5). This collar is even more developed in male boar, because the neck muscles play a crucial role in agonistic displays, while the thickness of the skin and underlying fat across the shoulders provides protection from the slashing tusks of rivals (Frädrich 1971, 137–8). Secondly, the gradient of declining utility from the proximal to distal parts of the limbs, and from the hindlimb to the forelimb, is significantly steeper in boar than in caribou and, to a lesser extent, sheep. In effect, for animals of similar body weight, fewer forelimbs and less of the lower limb would be worth transporting in boar than in caribou and perhaps sheep. Conversely, the upper neck (atlas/axis) would be significantly more attractive for transport in boar, especially during winter when the collar of fat is most developed, than in caribou or sheep. Finally, while the lumbar region has highest relative utility in boar, it would be fairly attractive for transport in all three species.

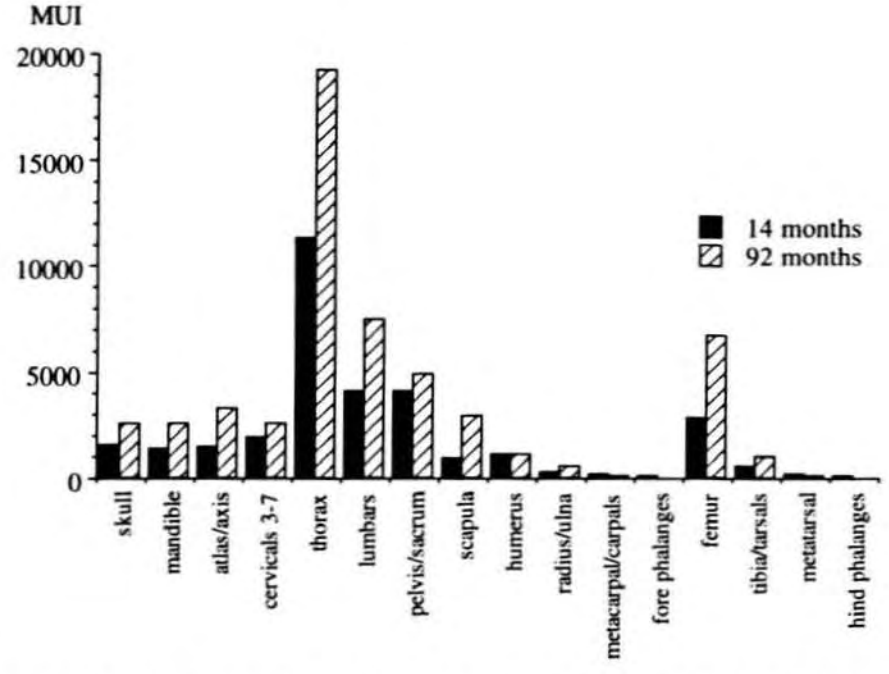

Figure 2. Comparison of Meat Utility Indices (MUI) for the 14- and 92-month old wild boar (weight in grams).

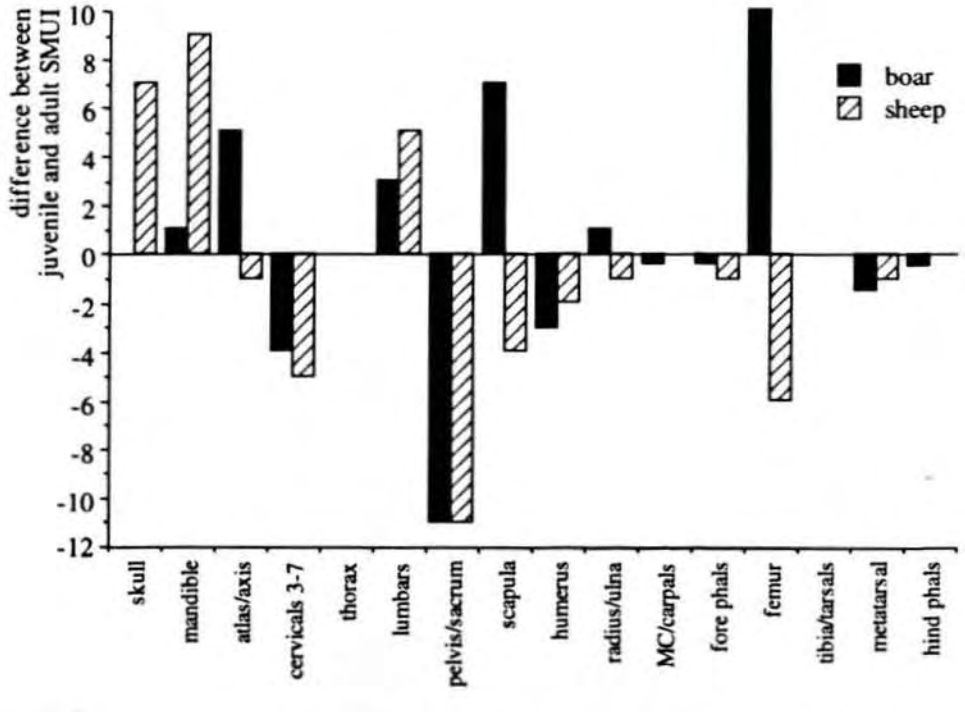

Figure 3. Comparison of SMUI indices for juvenile and adult animals, in wild boar and sheep. Wild boar calculated from Table 2. Sheep calculated from Table 3; original data from Binford (1978, Table 1.1).

element	6 months				90 months			
	total weight	dry bone weight	MUI	SMUI	total weight	dry bone weight	MUI	SMUI
skull	318	152	166	6	938	295	643	13
mandible w tongue	408	92	316	12	1194	168	1026	21
atlas/axis	272	53	219	8	408	88	320	7
cervicals 3-7	726	73	653	24	1089	137	952	19
thorax	2905	232	2673	100	5614	714	4900	100
lumbars	315	70	245	9	871	205	666	14
scapula	557	30	527	20	845	75	770	16
humerus	385	57	328	12	585	95	490	10
radius/ulna	214	45	169	6	325	89	236	5
metacarpal/carpals	87	32	55	2	135	52	83	2
fore phalanges	71	16	55	2	106	38	68	1
pelvis/sacrum	1140	122	1018	38	1624	320	1304	27
femur	986	73	913	34	1474	121	1353	28
tibia/tarsals	283	57	226	8	499	114	385	8
metatarsal	141	52	89	3	150	59	91	2
hind phalanges	56	16	40	1	100	38	62	1

Table 3. Meat Utility Index (MUI) and Standardised Meat Utility Index (SMUI) for two sheep butchered by Binford. Weights in grams from Binford (1978,Table 1.1); thoracic vertebrae, ribs and sternum are combined into a single 'thorax' unit, for comparison with the MUI and SMUI for wild boar.

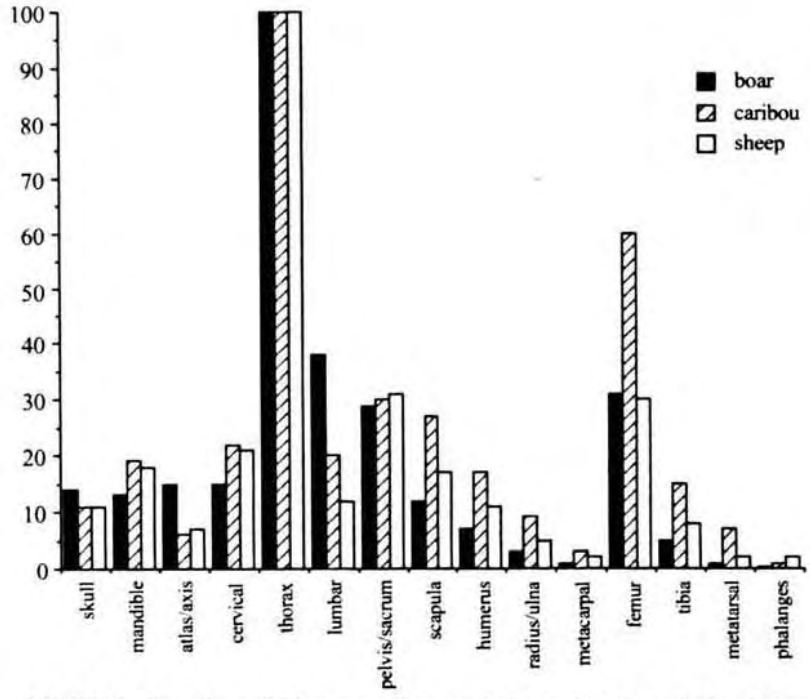

Figure 4. Comparison of SMUI indices for wild boar, caribou and sheep. The boar index is based on the mean values listed in Table 2. Caribou data are based on Metcalfe and Jones' (1988, Table 1) simplified MUI; for comparison to the boar, the values for thoracic vertebrae, ribs and sternum are summed as 'thorax' and the index recalculated. Sheep data are based on the means of the MUI values listed in Table 3.

Figure 5. Anterior view of the 92-month old wild boar after the removal of the head, showing the massive 'collar' of meat and fat (left). The position of the cervical vertebra is indicated by the arrow.

Zooarchaeological Application

The previous section has discussed the anatomical distribution of meat utility in boar. In zooarchaeological assemblages, selective discard or retention of skeletal parts is likely to have been influenced not just by the absolute utility of each part. As Binford (1978, 74) has argued, low-value parts may travel as 'riders' with adjacent parts of higher value. For this reason Table 4 presents FUI and SFUI values for boar. These indices enhance the relative values of lower limb elements. Due to the steeper gradient of declining utility in the boar lower limb noted above, the tibia and humerus are identified as elements of modest intrinsic utility which are particularly likely to be transported as 'riders' with adjacent elements of higher value.

The zooarchaeological application is to the wild boar assemblage from the site of Ringkloster in Denmark. This site lies on a lake shore some 20 km inland from the east coast of the Jutland peninsula. It dates mainly to the Late Mesolithic Ertebølle period, around 4700–3990 cal BC. The faunal remains were dumped into the lake by the Mesolithic inhabitants, and preserved by the accumulating lake peats. Preservation is therefore excellent (Andersen 1998). Use of a SFUI calculated from the mean MUI given in Table 1 is justified because about half of the wild boar from Ringkloster were dentally mature, aged over about 2.25 years, while half were younger.

Wild boar is the most common mammal, being represented by a NISP (= Number of Identified Specimens) of over 1900 fragments. Other species of different conformation are also present, particularly red deer (*Cervus elaphus* L.) and, less frequently, aurochs (*Bos primigenius* Bojanus). As in many archaeological assemblages, the representation of skeletal parts is highly variable (Fig. 6). Aurochs and red deer are similar: atlas and to a lesser extent axis vertebrae are much more common than any other skeletal part. Wild boar are substantially different: mandible and scapula predominate, followed by distal humerus, atlas and maxilla. In all three species, elements other than those mentioned are far less abundant.

At many sites such variability may be due to taphonomic factors such as carnivore gnawing or poor preservation, but at Ringkloster it has been argued that taphonomic factors are not likely alone to have created the patterns, for two main reasons.

unit	FUI	derivation	SFUI
skull	2.090	unmodified MUI	14
mandible	1.970	unmodified MUI	13
atlas/axis	2.360	unmodified MUI	15
cervicals 3-7	2.230	unmodified MUI	15
thorax	15.260	unmodified MUI	100
lumbar	5.765	unmodified MUI	38
scapula	1.885	unmodified MUI	12
P humerus	1.885	rounded up to scapula MUI	12
D humerus	1.490	mean of P hum FUI and hum MUI	10
P radius/ulna	0.950	mean of D hum FUI and rad MUI	6
D radius	0.680	mean of P rad FUI and rad MUI	4
carpals	0.405	mean of D rad FUI and m/c MUI	3
P metacarpal	0.270	mean of carpals FUI and m/c MUI	2
D metacarpal	0.200	mean of P m/c FUI and m/c MUI	1
pelvis	4.485	unmodified MUI	29
P femur	4.785	unmodified MUI	31
D femur	4.785	unmodified MUI	31
P tibia	2.785	mean of D fem FUI and tib MUI	18
D tibia	1.785	mean of P tib FUI and tib MUI	12
astragalus	0.960	mean of D tib FUI and m/t MUI	6
calcaneum	0.960	mean of D tib FUI and m/t MUI	6
tarsals	0.960	mean of D tib FUI and m/t MUI	6
P metatarsal	0.550	mean of tarsals FUI and m/t MUI	4
D metatarsal	0.345	mean of P m/t FUI and m/t MUI	2
phalanx 1	0.200	mean of D m/t FUI and phal MUI	1
phalanx 2	0.200	mean of D m/t FUI and phal MUI	1
phalanx 3	0.200	mean of D m/t FUI and phal MUI	1

Table 4. Food Utility Index (FUI) and Standardised Food Utility Index (SFUI) for wild boar. FUI values for each skeletal part are calculated from the mean Meat Utility Index (MUI) given in Table 1 and expressed in kilograms rather than grams; method of derivation is listed (see text and Metcalfe and Jones 1988:note 3 for discussion). The SFUI is each FUI value expressed as a percentage of the largest FUI value (that for thorax), given to the nearest 1%.

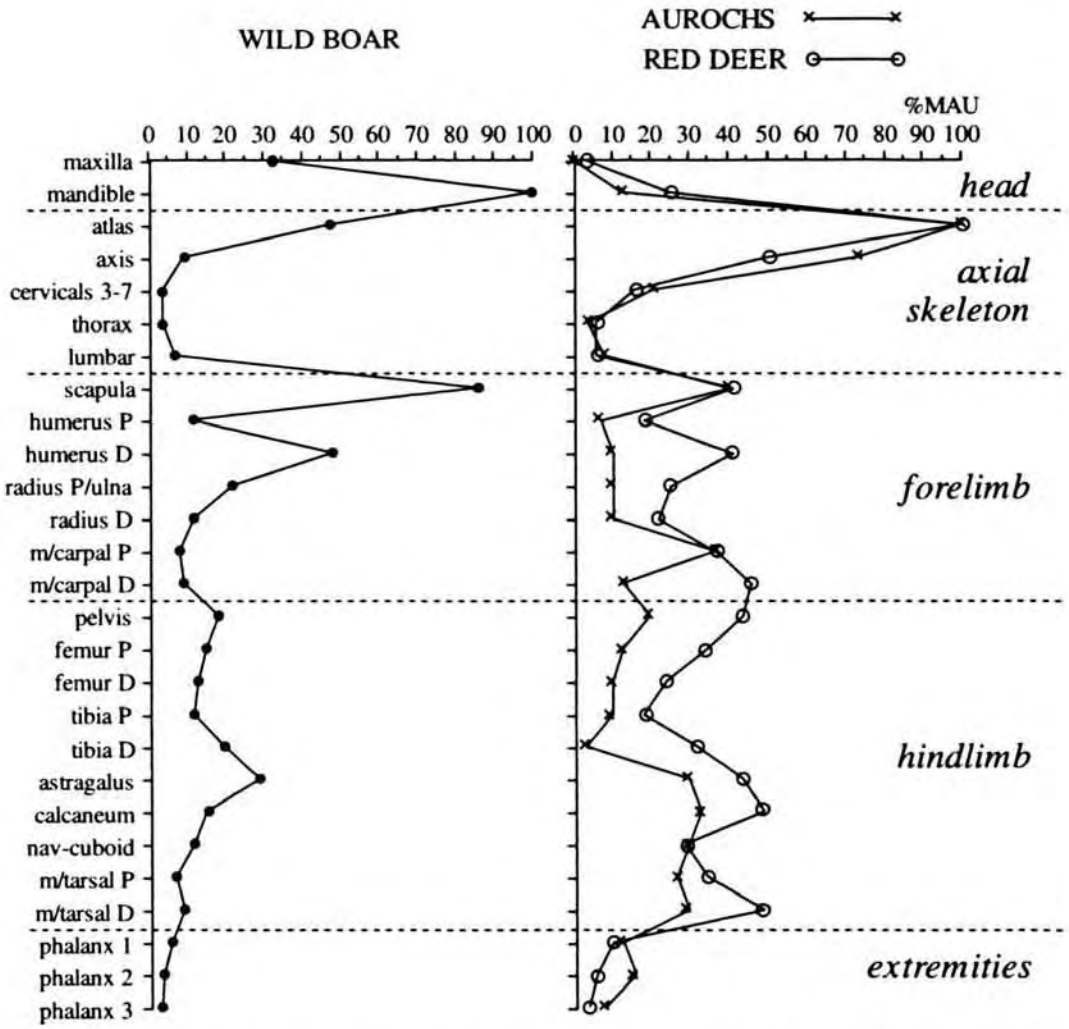

Figure 6. Frequency of skeletal parts of wild boar, aurochs and red deer at Ringkloster, calculated according to the Percent Minimum Animal Units (%MAU) method proposed by Binford (1984, 50–1). The maxilla, containing the upper teeth, is used as the measure of skull frequency.

Firstly, atlas and axis vertebrae are relatively soft bones and usually do not predominate in archaeological assemblages. Secondly, preservation in the lake peats at Ringkloster was exceptionally good and, once bones were dumped in the lake, dogs would no longer have had access to them (Rowley-Conwy 1993; 1998).

Ringkloster was seasonally occupied, from early winter to later spring. The bone representation patterns have been used to argue that the site was a hunting camp at which meat was processed and transported away to a base camp elsewhere. For aurochs and red deer, it was argued that heads and extremities were probably left at the kill-site, while the limbs (with the bones and their marrow) were transported elsewhere; atlas and axis were what remained at Ringkloster after carcass-processing. For wild boar, it was argued that the front end of the animal was eaten at Ringkloster, while the rear end was transported elsewhere; whether most of the vertebrae were abandoned at the kill-site, or taken to Ringkloster and then transported elsewhere, was unclear (Rowley-Conwy 1998).

This interpretation can now be explored further by plotting skeletal element representation of boar at Ringkloster against the new SFUI for the same species (Fig. 7). The resulting L-shaped scatter loosely approximates to an 'inverse-utility' curve of the sort expected on carcass processing sites from which high-value parts have been removed for consumption elsewhere. Thus, pelvis/sacrum, femur, lumbar vertebrae and, especially, thorax are of very high utility and are very poorly represented among the Ringkloster boar, while mandible and scapula are of modest utility and are very well represented archaeologically. On the other hand,

the foot bones (metacarpals, metatarsals and phalanges), which are of very low utility and are often discarded at the kill-site (Binford 1978), are also scarce, suggesting that Ringkloster was a hunting camp as originally argued by Rowley-Conwy (1998). Indeed, when skeletal element representation is plotted with body parts ranked in order of utility (Fig. 8), it is evident that the Ringkloster boar assemblage is dominated by parts of intermediate value, as expected of a hunting camp (Binford 1978; Legge and Rowley-Conwy 1988). Arguably, therefore, both low- and high-utility body parts are scarce at Ringkloster, because the former never reached the site, while the latter were brought to the site for

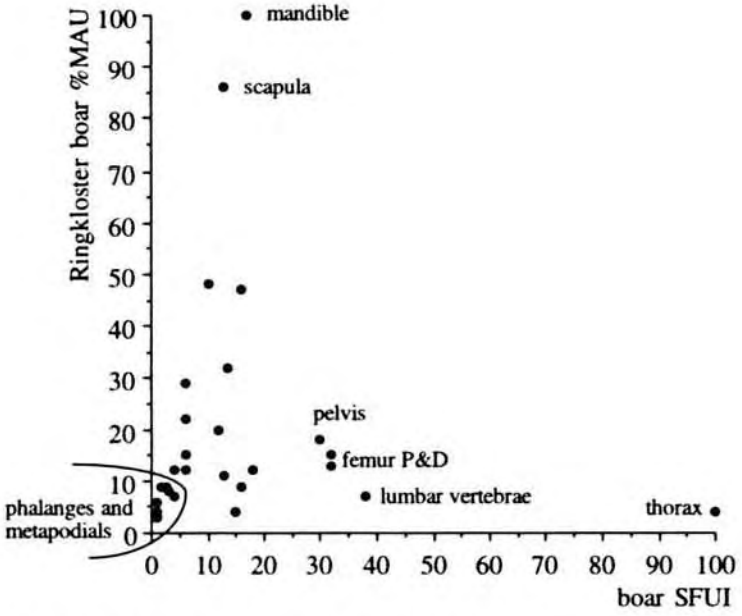

Figure 7. Comparison of boar skeletal element frequency at Ringkloster (%MAU) with the boar SFUI. Elements discussed in the text are identified.

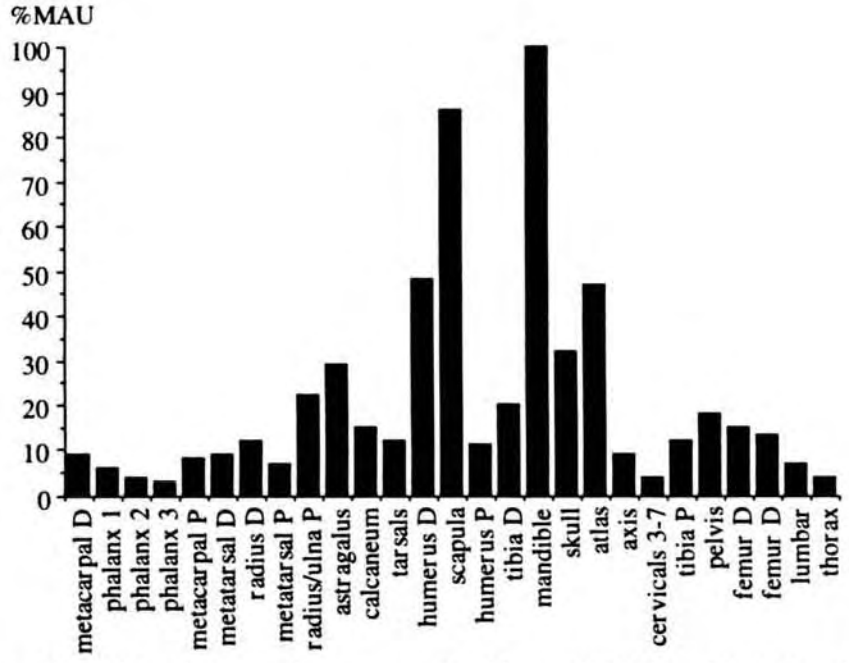

Figure 8. Comparison of boar skeletal element frequency at Ringkloster (%MAU) with the boar SFUI. Body parts are ranked in order of utility (low-utility parts to the left, high-utility parts to the right).

further processing and were then transported elsewhere. This interpretation is consistent with the logic of the utility index and with the observed behaviour of many modern hunters (Binford 1978), but there are obvious dangers that the skeletal representation data may be accommodated to an increasingly complex model in an *ad hoc* manner.

The goodness of fit between data and model will be more convincing if differences between species in body part representation match differences in species-specific utility indices. For heuristic purposes, the utility indices for caribou and sheep may be taken as broadly valid for red deer and aurochs. The earlier comparison of boar SMUI with those for caribou and sheep highlighted three distinctive features of the conformation of boar carcass which might be expected to have influenced any transport decisions at Ringkloster.

First, given that Ringkloster was occupied in winter, the fat-rich axis-atlas region of boar should have been very attractive for transport, and even more so if carcass parts selected for transport were intended to be stored. Encouragingly, one striking difference between skeletal representation of the different species at Ringkloster (Fig. 6) is the abundance of atlas and axis in aurochs and red deer and the contrasting rarity of axis in boar. Given the rarity of mandibles and maxillae (as an indicator of the skull) of aurochs and red deer, it seems likely that the heads of these two species were discarded at the kill-site and that the axis-atlas region was brought to Ringkloster together with the rest of the axial skeleton, but then discarded when the higher-utility thorax, lumbar region and lower neck were selected for onward transport. In boar, by contrast, the mandible and sometimes the whole skull were apparently removed from the kill-site and discarded at Ringkloster; in some cases, the atlas too was discarded at Ringkloster, possibly still attached to the skull. The axis is almost as severely under-represented as the remaining vertebrae, however, suggesting that the fat-rich collar was indeed normally selected for onward transport together with the lower neck, thorax and lumbar region.

Secondly, in boar, the hindlimb might have been strongly favoured for transport over the fore-limb, whereas more equitable treatment of fore and hindlimb would be expected in red deer and perhaps aurochs. At Ringkloster, the relative representation of fore and hind limb elements is strikingly even in red deer and (with the exception of scapula) aurochs, but strongly biased towards the forelimb in boar. The new utility index thus strongly supports Rowley-Conwy's original interpretation, that joints selected for onward transport included the upper parts of both fore and hindlimbs of red deer and aurochs and of hindlimbs of boar, while upper forelimbs of boar were consumed at Ringkloster.

Thirdly, in boar, fewer distal parts of the limb might be expected to be selected for transport than in red deer or aurochs. At Ringkloster, butchery marks are too few to be informative and so this expectation must be assessed against skeletal part representation. This exercise is complicated by the argument above that high-utility parts were consumed at Ringkloster, in the case of the forelimb of boar, but were transported elsewhere for consumption, in the case of the hindlimb of boar and both the fore and hindlimbs of red deer and aurochs. The evidence of skeletal representation suggests that the division of the hindlimb, into a proximal unit for onward transport and a distal unit for on-site consumption and discard, may have taken place between the distal tibia and the astragalus in all three species. In red deer and aurochs, the division of the forelimb seems similarly to have taken place between the distal radius and proximal metacarpal. In boar, however, the division of the forelimb (in this case, into a proximal unit for consumption and discard at Ringkloster and a distal unit for discard at the kill-site) seems to have taken place more proximally, between the distal humerus and proximal radius. This contrast between the species in the treatment of the forelimb is consistent with the distinctive nature of the MUI for wild boar.

It is also of interest that, in dividing boar carcasses into parts for transport and parts for discard, the inhabitants of Ringkloster treated the humerus (with scapula) and tibia (with femur and pelvis/sacrum) as high-utility parts. In terms of the Meat Utility Index, both humerus and tibia are rather low-value parts in boar and so, as disarticulated parcels of meat, should arguably not have been treated in the same way as scapula and femur-pelvis/sacrum, respectively. The frequencies of boar humerus and tibia at Ringkloster are consistent, however, with the Food Utility Index, which boosts the value of low-utility parts travelling as 'riders' with more proximal elements. This suggests that, at Ringkloster, the upper forelimb (scapula and humerus) and upper hindlimb (pelvis/sacrum, femur and tibia) of boar were each transported as single articulated units.

To varying degrees, therefore, the distinctive features of carcass conformation and utility in boar are reflected at Ringkloster in divergences in skeletal element representation between boar, red deer and aurochs. The consistency of the archaeological data with species-specific utility indices greatly strengthens the argument for interpreting variable representation of skeletal elements in terms of transport decisions by human hunters. The use of a more relevant utility index has also enabled a more

detailed and complete interpretation of hunters' decisions regarding the treatment of boar carcasses at Ringkloster (Fig. 1). Whereas the earlier discussions of this assemblage (Rowley-Conwy 1993; 1998) focused on the head and limbs of boar, the treatment of the remaining axial skeleton may also now be accounted for. It is argued that the thorax, lumbar region, lower neck and fat-rich collar around the axis in the upper neck were selected for onward transport from Ringkloster, in the same way as the upper part of the hindlimb. The atlas is relatively common at Ringkloster and was probably discarded here, together with (and still articulated with) the skull.

Conclusion

The analysis of a juvenile and an adult farmed boar in terms of food utility has demonstrated significant divergences, in certain parts of the carcass, from other terrestrial mammals of broadly comparable size for which utility indices are already available (caribou, sheep). This result is consistent with expectations, given the distinctive bodily conformation of boar. Comparison of the juvenile and adult boar has also demonstrated significant age-related differences in utility in certain parts of the carcass. The newly derived SFUI for boar has been applied to analysis of skeletal part frequency in the faunal assemblage from Mesolithic Ringkloster. The application of this species-specific utility index accounts for observed discrepancies in skeletal element representation between boar, red deer and aurochs in the Ringkloster assemblage. As a result, this assemblage may now be interpreted both in greater detail and with greater confidence as the outcome of transport decisions by human hunters. This application highlights the need for such analyses of skeletal element frequency to be based on utility indices specifically derived for each species and, ideally, for individuals of varying age, sex and nutritional status.

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